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Client:
Marshalltown Company

Advisor:
Dr. Wang

May-1310
Taylor Bouvin
Kok Aun Chee
Anna Grimley
Mike Kinsella
Jake Kyro

[PROJECT PLAN: IPOD BARCODE SCANNER]

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Acknowledgement

The 1310 team would like to thank Marshalltown Company for submitting this project. We would also like to thank Professor Wang for advising our team through this project.

Executive Summary

The purpose of this project is to develop an inexpensive barcode scanner that can be attached to an iPod Touch. This scanner will transfer data by audio through the TRRS jack of the iPod Touch. The reason for this, is that if data is to be transferred through the 30-pin connector we must be certified by Apple and obtain a special chip to do it. Marshalltown Company is certified by Apple to develop using the 30-pin connector but this would increase the price and complexity of the device. The device will have a hardware button that will initiate scanning and then transfer the data to the iPod Touch automatically.

In addition to developing the barcode scanner, a software library must be created for iOS so that the iPod Touch can interact with the scanning unit. The library must be able to receive information from the scanner and store it for future use. This is to be done by decoding the audio that is sent over the TRRS jack into a valid barcode. In addition, it must be able to send information to the barcode scanner. This will be done through the TRRS jack as well. The reason that the iPod should be able to send information to the scanner is because the iPod will need to tell the scanner when to start scanning. By having a generic library the barcode scanner can be used across many applications. As long as the developer has access to the library, they can create personalized applications that use the scanner.

Problem Statement

There needs to be a fast efficient way of scanning a large number of barcodes in a warehouse. This device needs to be portable so that the user can carry it around the warehouse and also up and down ladders if need be. The scanner also needs to be easily configurable, preferably attached to a mobile "smart" device, such as an iPod Touch. By having it connected to an iPod Touch the scanner will have much more possible functionality since it is connected to the Internet and is controlled by a fairly powerful device. An inexpensive way to transfer the data from the scanner to the iPod would be to go through its TRRS jack. By doing this, the special chip needed to communicate through the 30-pin connector wouldn't be needed which would decrease the price of the unit.

Solutions to this problem have been attempted in several different ways, but each has flaws that do not meet the client's expectations. IPods have apps that do scan barcodes, however, these use their built in cameras to scan them. This method is very slow and unreliable because the iPod must be held still while the camera scans, which may not be possible in a warehouse environment. Ample lighting is also needed which is also not always available. The dedicated barcode scanners currently on the market have limited functionality and are overly expensive. The device should also be easily detachable so that it can move to different devices if it needs to be. They are also extremely large and not very convenient to carry around a warehouse. Another smaller device that is similar to our design is a case that gives an iPod touch barcode and credit card scanning capabilities. This would solve our problem except for the fact that it also has functionality for scanning credit cards and is too expensive.

Limitations

This project will encounter many different problems and difficulties. One of the most important constraints to this project is the cost. The cost of other similar products is close to $500, but the client would prefer a product that could be developed in approximately $100. One of the most challenging limitations is the fact that the signal must go through the audio jack of an iPod. This limitation is the

most difficult because this will require that we develop a protocol for the signal and be able to decode and encode the signal with a very small margin of error. Sending this signal and the expected use of this product gives us the obvious limitation of power. We will have to examine whether the iPod itself will have sufficient power, or if an external power supply will be needed.

There are a few smaller issues that we will have to keep an eye on, but will most likely not have an integral role in development. The scanner has a small range, so if there is a future need for a longer ranged scanner, that will need to be considered in the design planning. The other small issue is the size. This product needs to be hand held and easily portable. This should not be a problem since our components are fairly small, but it is a limitation to keep in mind.

System Description

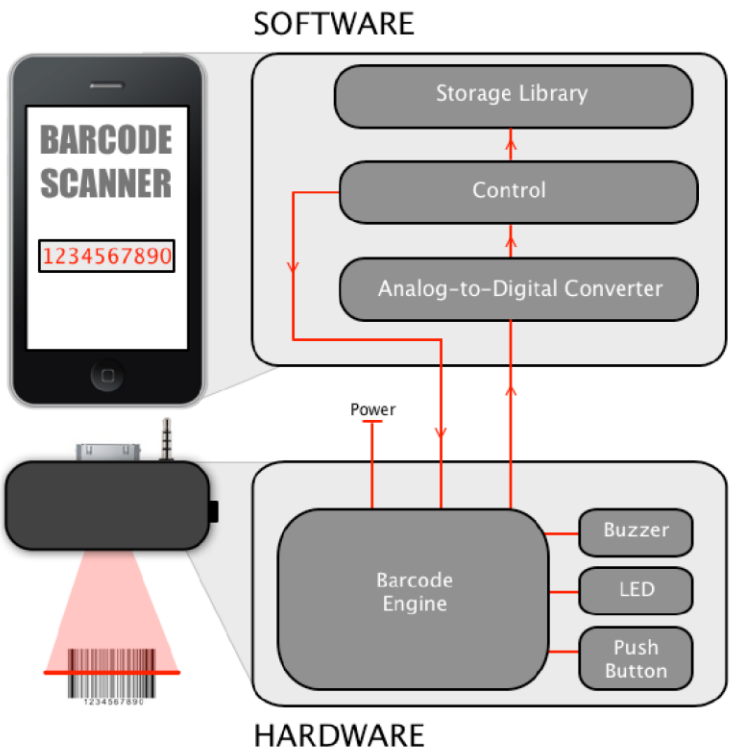
The design only requires the use of the Opticon MDL 1000 barcode scanning module and the microphone input on the iPod touch. When the push button is pressed, the barcode scanning module will scan a barcode and output a serial signal containing the data of the barcode. The hardware interface lowers the voltage level of the serial signal to that suitable for the microphone input level. The iPod touch samples the input of the microphone at a rate suitable for sampling the serial signal and the application on the iPod touch converts these samples into the appropriate bit values. These bit values will then be converted to ASCII characters and presented on the screen.

As one can see in the deprecated description below, in proof of concept this design was developed from a previous design that required a microcontroller. With the ability to not use a microcontroller this initial design is archived below.

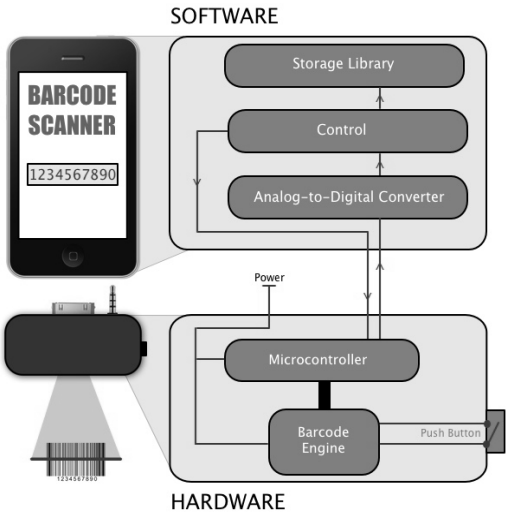
Deprecated

A barcode scanning engine will scan for a barcode when the push button is pressed and will send a signal to a microcontroller. The microcontroller will translate the signal provided by the barcode scanner into a stream of bits to be sent through a TRRS plug to an iPod touch. The microcontroller and barcode scanning engine will be powered through the 30 pin connector on the iPod. The iPod will have an application that is listening for a bitstream. The application will convert the bitstream from an analog signal to a digital signal. The application will analyze the bitstream to determine if the bitstream is error free. If the bitstream is determined to be corrupt the application will send a message to the microcontroller to continue scanning the barcode until a valid barcode has been read by the application or until the push button has been released. Once a barcode has been successfully read the application will store the barcode information in a library. The library of successfully scanned barcodes will be queried by an existing application developed by Marshalltown Company.

Block Diagram



Deprecated



Functional System Requirements

The high-level functional requirement for this project is to communicate between the Opticon MDL 1000 (Fig. 1) 1-D barcode scanner engine and an Apple iPod Touch through its TRRS audio jack. This barcode engine communicates digitally with RS-232 serial interface. Specifications for this form of communication to take note of include: the voltage levels, signaling rate, timing and slew-rate of the signals.

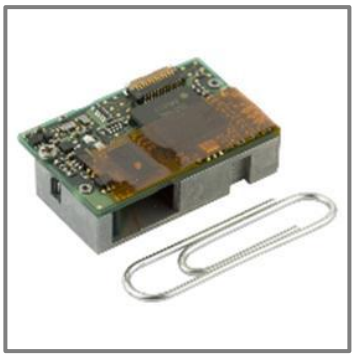


Figure 1: Opticon MDL 1000

The barcode scanner will pass the serial data of the barcode directly to the iPod Touch. The iPod Touch's software will sample the signal and determine the barcode being sent. It will then display the full barcode on the screen.

An external switch is required to trigger and initiate a scan. Every time a scan is initiated, the result of the barcode data should be displayed on the iPod Touch.

In order for the iPod Touch to receive input through the TRRS audio jack, the iPod Touch has to detect the presence of a microphone across the 2nd Ring and Sleeve connection.

Deprecated

Since communication to the iPod Touch's audio jack uses analog audio signals, a microcontroller for digital to analog conversion is required to convert and encode the digital RS-232 serial signals into analog audio for the iPod. Software will be written in Objective-C for monitoring the audio input stream via the iPod Touch's TRRS microphone (the Sleeve of TRRS connection) input. The software will also have to decode the audio data encoded by the microprocessor.

Non-Functional Requirements

The barcode scanner and microcontroller interface should be powered through the Apple iPod Touch's 30-pin connector. Optionally, a secondary battery can be added to be used as a backup reservoir to power both the scanner side along with its interface and the iPod Touch. The total cost of the interface (inclusive of the barcode scanning engine) should be less than $100. Each barcode scanning engine cost approximately $60. Therefore, the interface should be less than $40.

Intended Users

The intended users for this device are warehouse employees. Employees will be using this device to scan barcodes of products that come in to the warehouse. It will be used by the employees multiple times a day and will be used all over a very large warehouse where heavy machinery will be in use.

Deliverables

The expected outcomes of this project can be broken down into two areas: hardware and software.

From a software perspective:

- Software will be written in Objective-C to monitoring and decode the analog input stream through the TRRS jack

  Deprecated

  A microcontroller will be programmed to convert the barcode engine output into an analog signal that can be read across the TRRS jack

From a hardware perspective:

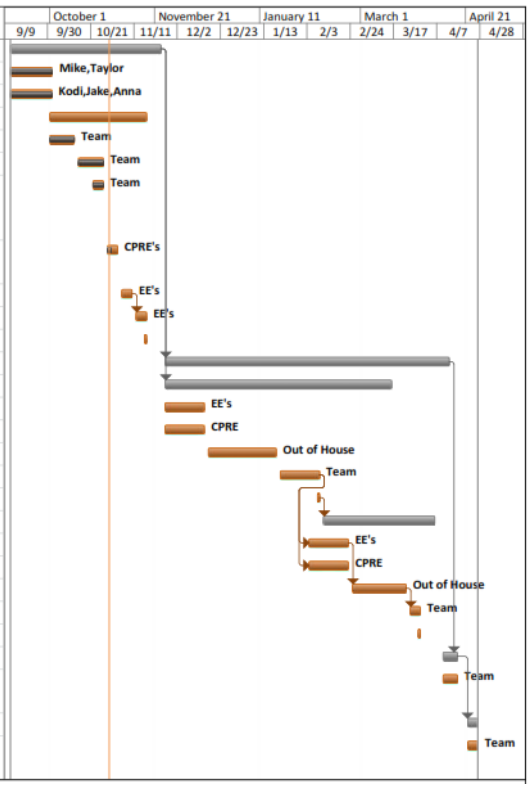
- A schematic of the circuit will be made
- A layout will be designed for a small PCB that can be implemented into any casing the client would designed in the future
- A final functioning PCB will be made by May 2013 with a bill of materials (BOM) cost of less than $100

Tasks

Task Name	Duration	Start	Finish
Project Definition	10 wks	Wed 9/12/12	Fri 11/23/12
Define Software Deliverables	14 days	Wed 9/12/12	Mon 10/1/12
Define Hardware Deliverables	14 days	Wed 9/12/12	Mon 10/1/12
Proof of concept	7 wks	Mon 10/1/12	Fri 11/16/12
Understand Microcontroller	2 wks	Mon 10/1/12	Fri 10/12/12
Understand Bar Code Engine	2 wks	Mon 10/15/12	Fri 10/26/12
Communicate between Microtcontroller and Barcode Engine	1 wk	Mon 10/22/12	Fri 10/26/12
Communicate between Mictrocontroller and Ipod	1 wk	Mon 10/29/12	Fri 11/2/12
Begin Design	1 wk	Mon 11/5/12	Fri 11/9/12
Have Schematic Finished	1 wk	Mon 11/12/12	Fri 11/16/12
Project Definition Complete	1 day	Fri 11/16/12	Fri 11/16/12
Project Design	5 mons	Mon 11/26/12	Fri 4/12/13
Alpha Design	4 mons	Mon 11/26/12	Fri 3/15/13
Alpha-PCB	3 wks	Mon 11/26/12	Fri 12/14/12
Alpha-Software	3 wks	Mon 11/26/12	Fri 12/14/12
Alpha Fabrication	5 wks	Mon 12/17/12	Fri 1/18/13
Testing	3 wks	Mon 1/21/13	Fri 2/8/13
Alpha Design Complete	1 day	Fri 2/8/13	Fri 2/8/13
Beta Design	8 wks	Mon 2/11/13	Fri 4/5/13
Beta-PCB	3 wks	Mon 2/4/13	Fri 2/22/13
Beta-Software	3 wks	Mon 2/4/13	Fri 2/22/13
Beta Fabrication	1 mon	Mon 2/25/13	Fri 3/22/13
Testing	1 wk	Mon 3/25/13	Fri 3/29/13
Beta Design Complete	1 day	Fri 3/29/13	Fri 3/29/13
Implementation	1 wk	Wed 4/10/13	Tue 4/16/13
Deliver board to client to be enclosed into case	1 wk	Wed 4/10/13	Tue 4/16/13
Verification	1 wk	Mon 4/22/13	Fri 4/26/13
Help Client troubleshoot and implementation	1 wk	Mon 4/22/13	Fri 4/26/13

Gant Chart of Schedule

ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1		**Project Definition**	10.6 wks	Wed 9/12/12	Fri 11/23/12		
2		Define Software Deliverables	14 days	Wed 9/12/12	Mon 10/1/12		Mike,Taylor
3		Define Hardware Deliverables	14 days	Wed 9/12/12	Mon 10/1/12		Kodi,Jake,Anna
4		Proof of concept	7 wks	Mon 10/1/12	Fri 11/16/12		
5		Understand Microcontroller	2 wks	Mon 10/1/12	Fri 10/12/12		Team
6		Understand Bar Code Engine	2 wks	Mon 10/15/12	Fri 10/26/12		Team
7		Communicate between Microtcontroller and Barcode Engine	1 wk	Mon 10/22/12	Fri 10/26/12		Team
8		Communicate between Mictrocontroller and Ipod	1 wk	Mon 10/29/12	Fri 11/2/12		CPRE's
9		Begin Design	1 wk	Mon 11/5/12	Fri 11/9/12		EE's
10		Have Schematic Finished	1 wk	Mon 11/12/12	Fri 11/16/12	9	EE's
11		Project Definition Complete	1 day	Fri 11/16/12	Fri 11/16/12		
12		**Project Design**	5 mons	Mon 11/26/12	Fri 4/12/13	1	
13		**Alpha Design**	4 mons	Mon 11/26/12	Fri 3/15/13	1	
14		Alpha-PCB	3 wks	Mon 11/26/12	Fri 12/14/12		EE's
15		Alpha-Software	3 wks	Mon 11/26/12	Fri 12/14/12		CPRE
16		Alpha Fabrication	5 wks	Mon 12/17/12	Fri 1/18/13		Out of House
17		Testing	3 wks	Mon 1/21/13	Fri 2/8/13		Team
18		Alpha Design Complete	1 day	Fri 2/8/13	Fri 2/8/13		
19		**Beta Design**	8 wks	Mon 2/11/13	Fri 4/5/13	18	
20		Beta-PCB	3 wks	Mon 2/4/13	Fri 2/22/13	17	EE's
21		Beta-Software	3 wks	Mon 2/4/13	Fri 2/22/13	17	CPRE
22		Beta Fabrication	1 mon	Mon 2/25/13	Fri 3/22/13	20	Out of House
23		Testing	1 wk	Mon 3/25/13	Fri 3/29/13	22	Team
24		Beta Design Complete	1 day	Fri 3/29/13	Fri 3/29/13		
25		**Implementation**	1 wk	Wed 4/10/13	Tue 4/16/13	12	
26		Deliver board to client to be enclosed into case	1 wk	Wed 4/10/13	Tue 4/16/13		Team
27		**Verification**	1 wk	Mon 4/22/13	Fri 4/26/13	25	
28		Help Client troubleshoot and implementation	1 wk	Mon 4/22/13	Fri 4/26/13		Team



Resources Required

The resources required for this project will be supplied fully by the client. One of the most important resources is the actual iPod Touch used to operate the product. Along with the iPod, a developer license is required to develop applications for any Apple product. There is a 1-D barcode scanner needed to create the audio signal. A possible resource pending design concerns is an independent battery to provide extra power to the device. Other miscellaneous resources such as wires and other small electrical equipment are cheap and will be provided whenever needed.